# Photoexcited TiN Nanoheaters in Nanoporous Anodized Aluminum Oxide for High-Efficiency Water Desalination

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Titanium nitride (TiN) nanoparticles (NPs) act as excellent solar-heat nano-generators due to their broadband plasmonic resonances together with their chemical stability. Our initial study reported in ref. [1] studied the TiN NPs dispersed in water.

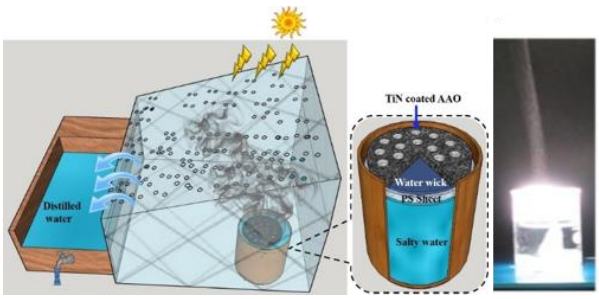


*Figure 1. Schematic of TiN coated AAO converts incident solar energy into thermal energy.*

To take advantage of capillary force and to make TiN NPs easy to recycle, our next study has demonstrated a floating composite structure composed of TiN NPs and transparent ceramic fibers with improved solar steam generation efficiency upto 52% [2]. In the current project with the motive to drastically improve the solar steam generation efficiency, we develop a cost-effective, reusable and efficient composite ceramic structures using anodized aluminum oxide (AAO) membrane to form "*nanoscale solar steam generator*." **Figure 1** shows the schematic of the TiN coated AAO which converts the incident solar energy into thermal energy by the photothermal process and generate steam efficiently.

This composite structure traps the absorbed solar energy at the composite-water interface to enable effective steam generation while suppressing the unnecessary heating of the subsurface water. Our studies have shown that photothermal performance of the TiN-AAO can be optimized by adjusting the pore diameter and TiN thickness [3]. This structure has 92% steam generation efficiency under solar irradiation of 100 mW $cm^{-2}$.

Additionally, an attempt to measure the local temperature of the AAO-TiN hybrid structure at the nanoscale level has been performed through the observation of the Stokes peak shift in Raman spectroscopy. We have presented the mechanism of nano-heating, effects of the capillary action of water, as well as the thermal management in the AAO-TiN and polystyrene (PS) sheet system. A thermal insulation by a PS sheet was effective in improving the water evaporation speed. The proposed low cost and concise design make our material an excellent candidate for the portable solar steam generator [3,4].

[1] S. Ishii, R. P. Sugavaneshwar, T. Nagao, *The Journal of Physical Chemistry* **C** *120,* 2343(2016).

[2] M. Kaur, S. Ishii, S. L. Shinde, T. Nagao, *ACS Sustainable Chemistry & Engineering* 5, 8523(2017).

[3] M. Kaur, S. Ishii, S. L. Shinde, T. Nagao, *Advanced Sustainable Systems* 3, 1800112 (2018).

[4] Featured in TV Tokyo (TBS) News "*World Business Satellite*" (Broadcasted on 31 May 2019).